

CLAIMS

We claim:

1. An ultrasonic flow meter configured to measure a flow within a conduit, comprising:
 - first and second transducers;
 - a printed circuit board including circuitry for conducting ultrasonic transit time flow measurements, the printed circuit board including a transducer swap relays; and
 - first and second transducer cables connecting the first and second transducers, respectively, to the transducer swap relay;
 - a programmable processor included on the printed circuit board that is configured to generate flow measurement data based on an ultrasonic flow meter calibration performed by the ultrasonic flow meter in situ while measuring flow through the conduit, the calibration including the steps of:
 - determining a zero offset value,
 - determining a swap offset value by measuring transit time difference (ΔT) forward and backward between the first and second transducers through the flow in the conduit, activating the transducer swap relays to physically swap the first and second transducers, and measuring transit time difference forward and backward between the swapped first and second transducers through the flow in the conduit,
 - determining a flow zero value based on the zero offset and swap offset,
 - and
 - generating flow rate data based on the flow in the conduit and the flow zero offset.
2. The flow meter of claim 1, wherein determining a swap offset value includes generating a forward average based on a plurality of measurements taken before activating the

transducer swap relays and generating a reverse average based on a plurality of measurements taken after activating the transducer swap relays.

3. The flow meter of claim 1, wherein the transducer swap relays are electromechanical relays.

4. The flow meter of claim 1, wherein generating flow rate data includes calculating an average of a standard flow rate based on one or more measurements taken before activating the transducer swap relays and a swapped flow rate based on one or more measurements taken after activating the transducer swap relays.

5. The flow meter of claim 1, wherein the processor is configured to initiate ultrasonic flow meter calibration based on a user input.

6. The flow meter of claim 1, wherein the processor is configured to initiate ultrasonic flow meter calibration periodically.

7. The flow meter of claim 1, wherein the processor is configured to monitor the flow rate to identify a steady flow rate prior to initiating ultrasonic flow meter calibration.

8. A computer-implemented method for zeroing an ultrasonic flow meter configured to measure a flow within a conduit using a programmable processor of the flow meter implementing zeroing instructions stored in non-transient memory, the steps comprising:

determining a zero offset value based on measured transit time forward and

backward between first and second transducers through a flow in a conduit;

determining a swap offset value by

measuring transit time forward and backward between first and second transducers through the flow in the conduit,

activating a transducer swap relays on a printed circuit board of the flow meter that is connected to the first and second transducers by first and second

transducer cables, respectively, to physically swap the first and second transducers, and

measuring transit time forward and backward between the swapped first and second transducers through the flow in the conduit;

determining a flow zero value based on the zero offset and swap offset; and

generating flow rate data based on the flow in the conduit and the flow zero offset.

9. The method of claim 8, wherein determining a swap offset value includes generating a forward average based on a plurality of measurements taken before activating the transducer swap relays and generating a reverse average based on a plurality of measurements taken after activating the transducer swap relays.

10. The method of claim 8, wherein the transducer swap relays are electromechanical relay.

11. The method of claim 8, wherein generating flow rate data includes calculating an average of a standard flow rate based on one or more measurements taken before activating the transducer swap relays and a swapped flow rate based on one or more measurements taken after activating the transducer swap relays.

12. The method of claim 8, wherein the processor is configured to initiate ultrasonic flow meter calibration based on a user input.

13. The method of claim 8, wherein the processor is configured to initiate ultrasonic flow meter calibration periodically.

14. The method of claim 8, wherein the processor is configured to monitor the flow rate to identify a steady flow rate prior to initiating ultrasonic flow meter calibration.

15. An ultrasonic flow meter configured to measure a flow within a conduit, comprising:
- first and second transducers;
 - a printed circuit board including circuitry for conducting ultrasonic transit time flow measurements, the printed circuit board including transducer swap relays; and
 - first and second transducer cables connecting the first and second transducers, respectively, to the transducer swap relay;
 - a programmable processor included on the printed circuit board that is configured to generate flow measurement data based on an ultrasonic flow meter calibration performed by the ultrasonic flow meter, the calibration including the steps of:
 - determining a zero offset value,
 - determining a swap offset value by measuring transit time forward and backward between the first and second transducers through the flow in the conduit, activating the transducer swap relays to physically swap the first and second transducers, and measuring transit time forward and backward between the swapped first and second transducers through the flow in the conduit,
 - determining a flow zero value based on the zero offset and swap offset.
16. The flow meter of claim 15, wherein determining a swap offset value includes generating a forward average based on a plurality of measurements taken before activating the transducer swap relays and generating a reverse average based on a plurality of measurements taken after activating the transducer swap relays.
17. The flow meter of claim 15, wherein the transducer swap relays are electromechanical relay.
18. The flow meter of claim 15, wherein generating flow rate data includes calculating an average ΔT to produce a flow rate based on one or more measurements taken before activating the transducer swap relays and a swapped flow rate based on one or more measurements taken after activating the transducer swap relays.

19. The flow meter of claim 15, wherein the processor is configured to initiate ultrasonic flow meter calibration based on a user input.

20. The flow meter of claim 15, wherein the processor is configured to monitor the flow rate to identify a steady flow rate prior to initiating ultrasonic flow meter calibration.